International Journal of Agricultural Science and Research (IJASR)
ISSN(P): 2250-0057; ISSN(E): 2321-0087
Vol. 7, Issue 1, Feb 2017, 517-522

TRANS STELLAR
•Journal Publications •Research Consultancy

A SIMPLE MICELLER THIN LAYER CHROMATOGRAPHIC METHOD FOR THE SEPARATION OF VARIOUS HEAVY METAL IONS ON BISMUTH SILICATE LAYER

SARANG S DHOTE

Assistant Professor, Department of Chemistry, Bhiwapur, Mahavidyalaya Bhiwapur, India

ABSTRACT

Thin Layer in combination with surfactants has been used to study various characteristics in terms of separation and mobilities on newly developed adsorbents. Thin layer of bismuth silicate on glass plates were used as adsorbent. Chromatographic plates were developed by using aq. Surfactants and using other organic solvents. Ethanol was found to be most effective additive at 10% concentration with 5% Tween-20. This method successfully applied to identification and separation of Co^{2+}, Cu^{2+} and Fe^{3+} from river water, agricultural soil and industrial waste water. This TLC method is rapid, with development times averaging 2 min. method was successfully used for study of various metal cations from various agriculturalsoils.

KEYWORDS: Miceller, Bismuth Silicate, Tween 20, Adsorbent, & TLC

Received: Dec 09, 2017; **Accepted:** Jan 31, 2017; **Published:** Feb 10, 2017; **Paper Id.:** IJASRFEB201765

Original Article

INTRODUCTION

Application of various surfactants as a mobile phase found to be good for separation of various components from multi component systems. It was noticed first time by Armstrong and co workers[1].Efficiency of mobile phase in the separation of cations [2,3] and anions [4,5] has been reported and reviewed by Okada [6]. Mullins and Kirk bright [7] used MLC as an alternative ions chromatography for the separation of several inorganic ions using a cationic miceller eluent. Kirkman et al. [8] used variety of miceller eluents to examine the chromatographic behavior of ionic, nonionic, chelated and organometallic species. A few studies reported the use of surfactant – mediated systems in thin layer chromatography of inorganics [9-11]. However, none of these studies examined miceller TLC separation of heavy metal cations. Various thin layer chromatographic methods [12&13] gives successful results for quantitative separation of UO_2^{2+}.

The current methodology explores the analytical application of aqueous surfactants with various organic surfactants mobile phase for the separation of various toxic metal ions from various environmental sample like river water, industrial waste & agricultural soil.

EXPERIMENTAL PROCEDURES

Apparatus

A Thin Layer Chromatography chamber from Raj Chemicals was used. A labtronics pH Meter was used for determination of pH

Chemical and Reagent

Tween- 20, SDS and BAC was obtained from Merk.Nitrates and silicates of bismuth and sodium were obtained from Loba Chemicals India. All other chemicals were of analytical grade.

Metal Ion Studied

Salts of various metals were obtained from Loba Chemicals India. Test solutions 1% of these metal ions were prepared in double distilled water. 1% alcoholic dimethylglyoxime, 1% aq. potassium ferrocynide &a freshly prepared dithiozone solution (0.05% in chloroform) was used to detect the metal cations from chromatographic plates.

Solvent Systems

The following solvents systems were used as mobile phases: (a) Surfactant- free solvent systems: water, ethanol, DMF, DMSO, 1-4 Dioxane, water + DMSO, ethanol + water in 9:1, 8:2, 7:3, 1:1 ratio by volume; (b) aq. systems with surfactant : Tween-20(0.001% - 15%), BAC (1%, - 7%) and SDS (1%, - 7%), Tween-20 (10%) + ionic additives. (c) hydro-organic systems with added surfactants: solvent systems consisting of aq. solution Tween-20(1%, - 10%) and organic solvents in different volume ratios.

THIN LAYER CHROMATOGRAPHY

Thin Layer Chromatographic separation for various toxic metal cations were carried on using newly developed bismuth silicate thin layer. Plates of bismuth silicate were prepared by using method were discussed in [14]. After preparation of plates separation and quantitative estimation of various metal cations were carried by using spot area measurement method as described by Dhote Sarang et al [14]. 5% Tween-20+ Ethanol (9:1 v/v) solvent was found to be good for quantitative estimation of UO_2^{2+}. The recovery of $UO_2^{2+}$was 65 ± 5 %. Results are shown in Figure 1.

RESULTS

Thin layer chromatographic behaviors of various metal cations are studied with the help of surfactants at various concentration levels. From that it was observed that good separation and compact spot were observed in case of Tween -20 as compared to other surfactant solvents system. Therefore Tween-20was selected for further studies and metal ions were chromatographed using different aqueous concentration of Tween - 20 (0.001 – 15%) as mobile phase. After chromatographic separation following results were obtained.

- At concentration below 0.5% maximum metal gave a tailed spot. So that solvent systems below 0.5% were discarded. From 0.5% concentration systems tailing of spot was decreases and compactness was increases.
- Separation required approximately 2-3 minutes.

Apparently, the several types of concentration dependant structure formed by surfactant molecule, with a conjoined change in the size of their aggregates [15], do not considerably affect metal ion mobility. Mixed type surfactants solvents mobile phase was found to be good for separation of heavy metal cations. And hence various additives were added in aq. Tween -20 Mobile phase systems.

- Surfactants with DMF additives did not have any considerable changes in mobility of metal cations.

- Methanol Containing surfactant mobile phase system was gave tailed spot in entire range of concentration of methanol.
- Tween -20 with ethanol was found to be best mobile phase for separation of heavy metal cations with compact spot. And hence further study was made continue with the use of ethanol as additive in surfactants.
- Many metal cations are detected they remain on point of applications.

Table 1 reports the R_F value of metal ions in certain aqueous mobile phases with and without added surfactant..

Table 1: Migration of Various Metal Ions

Metal Ions	Pure Water	5% Aqueous Tween -20	Water/ Ethanol (9:1)	5% Tween-20/ Ethanol (9:1)
Cu^{2+}	0.25T	0.54T	0.10	0.56
Zn^{2+}	0.24T	0.00	0.39T	0.88
Pb^{2+}	0.25	ND	0.21	0.92
Fe^{3+}	0.41	0.12	0.18	0.15
Ni^{2+}	0.54	0.65	0.50T	0.68
Co^{2+}	0.42	0.68	0.55T	0.68T
UO_2^{2+}	0.15	0.24	0.22	0.32
VO^{2+}	0.15	0.17	0.22	0.54
Hg^{2+}	0.78	0.77	0.74	0.72
Ag^{2+}	0.10	ND	0.22	0.78
Cd^{2+}	0.65T	0.45	0.50T	0.93

R_F value is an average of three replicate determinations. ND: - Not detected; T: - Tailed spot.

The separation achieved experimentaly with different miceller mobile phases on bismuth silicate layers listed in Table 2.

Table 2: Separations on Bismuth Silicate thin Layer with Various Mobile Phases

S. No.	Mobile Phase	R_f Values.
1	5% Tween- 20	Zn^{2+} (0.11), Ni^{2+} (0.78)
2	5% Tween- 20 / DMSO (9:1)	Hg^{2}+ (0.78), UO_2^{2+} (0.40), Zn^{2+} (0.10) Zn^{2+} (0.10), Cu^{2+} (0.45)
3	5% Tween- 20 /DMSO/Ethanol (8:1:1)	Hg^{2+} (0.75), UO_2^{2+} (0.40), Zn^{2+} Zn^{2+} (0.13)
4	5% Tween- 20 / DMF (7:3)	Zn^{2+} (0.15), Cu^{2+} (0.40), Hg^{2+} (0.80)
5	5% Tween- 20 / Ethanol (7:3)	Zn^{2+} (0.11), Ni^{2+} (0.50), Hg^{2+} (0.89) Zn^{2+} (0.10), Ni^{2+} (0.45), Cd^{2+} (0.90)
6	5% Tween- 20 / Ethanol (9:1)	Zn^{2+} (0.11), Cu^{2+} (0.60), Zn^{2+} (0.76) Zn^{2+}(0.10), Cu^{2+} (0.50), Cd^{2+} (0.82) Zn^{2+}(0.10), Cu^{2+} (0.40), Co^{2+} (0.89) Zn^{2+} (0.10), Cu^{2+} (0.53), Hg^{2+} (0.80)

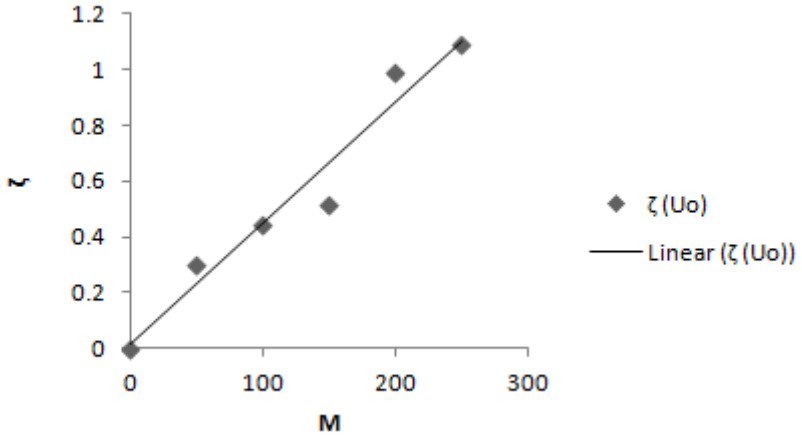

Figure 1: Semiquantitative Determination of UO_2^{2+}

CONCLUSIONS

Ethanol is helpful for preventing the hydrolysis of metal ions and hence all metal produce compact spot. After several experiments 5% Tween – 20 containing 10% ethanol were used for further study. It was observed that solvent containing protons were found to be good mobile phase in combination with nonionic surfactant that is Tween - 20 as compared with organic solvents.

APPLICATION

Current method successfully used to separation and identification of Co^{2+}, Cu^{2+} and Fe^{3+} in industrial wastewater, Agricultural soil and river water sample. The result listed in Table 3.

Table 3: Identification and Separation of Mixtures

Spiked/Synthetic Samples	R_F values		
	Co^{2+}	Cu^{2+}	Fe^{3+}
River water	0.52	0.25	0.10
Industrial Waste Water	0.58	0.34	0.09
Agricultural Soil	0.57	0.33	0.15

ACKNOWLEDGEMENTS

The authors would like to thank the principal of Bhiwapur Mahavidyalaya and head of the Department of Chemistry, Hislop College Nagpur, M.S., India for the provision of the research facilities used in our study.

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